UCRL-JC-125124 Abs

Beryllium Fuel Capsules for the NIF

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Abstract

We have developed a magnetron sputtering process capable of fabricating the beryllium fuel capsules for laser fusion experiments at the National Ignition Facility. The process involves the deposition of beryllium on spherical mandrels with an array of small magnetron sputtering sources. Capsules meeting a preliminary design specification were prepared by depositing 134 μm of beryllium on 0.5 mm diameter polystyrene microshells. A uniform coating thickness was achieved by randomly bouncing the capsules in a pan oscillated at high frequencies. The use of a copper alloy target in one of the sputtering sources made it possible to dope the initial 39 μm of beryllium coating with a concentration profile that gradually changed from a few atomic percent to pure beryllium. The process parameters selected for these early experiments produced beryllium capsules surprisingly close to meeting the stringent design requirements for ICF target on sphericity, surface roughness, microstructure, and composition. Also, preliminary experiments indicate that the unusual microstructure caused the beryllium capsules to have gas permeation characteristics controlled by the polystyrene mandrel. The potential benefit of this unexpected result is the possible use of existing cryogenic gas-filling techniques on these beryllium capsules without the need for fill-tubes. These experimental results together with the batch processing capability and the material flexibility of magnetron sputtering make it an attractive process for fabricating the advanced fuel capsule designs proposed for NIF.

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract No. W-7405-ENG-48.